Towards combined global monthly gravity field solutions

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EGU General Assembly, G4.2, 01 May 2014

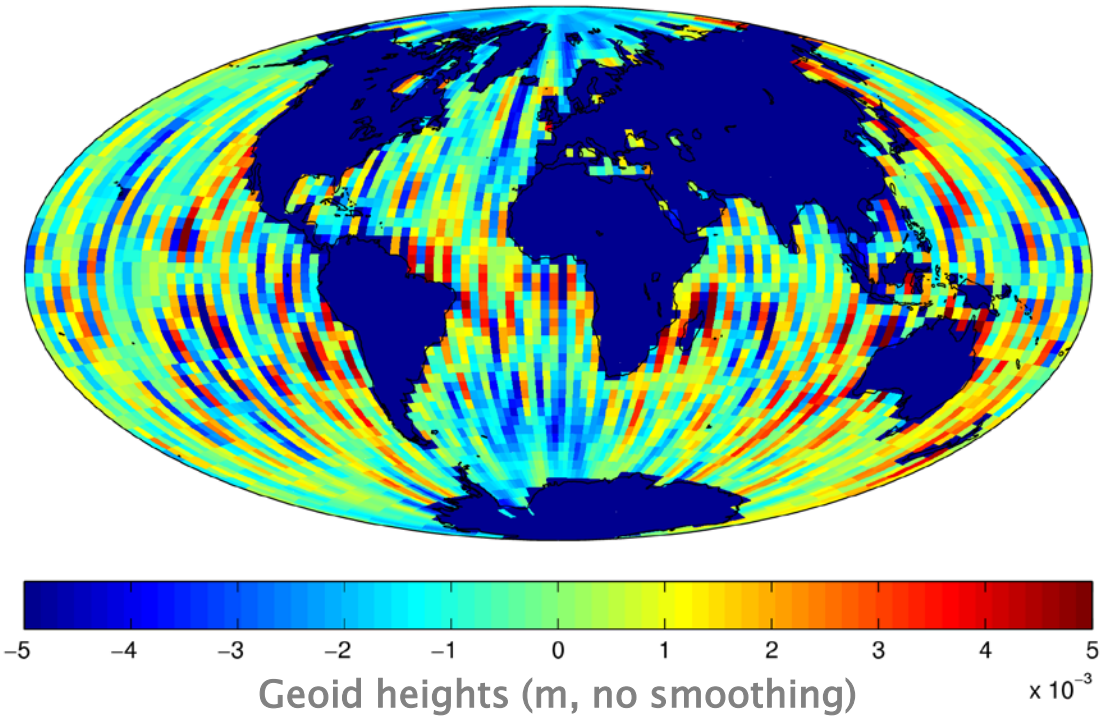
Motivation

Today, a variety of time-variable GRACE solutions are available from different groups:

- The solutions differ in terms of noise and (maybe) signal
- They may be based on different methodologies
- What can be done to make the best possible use of all these solutions?
- Is it possible to establish a meaningful combination?

Noise assessment

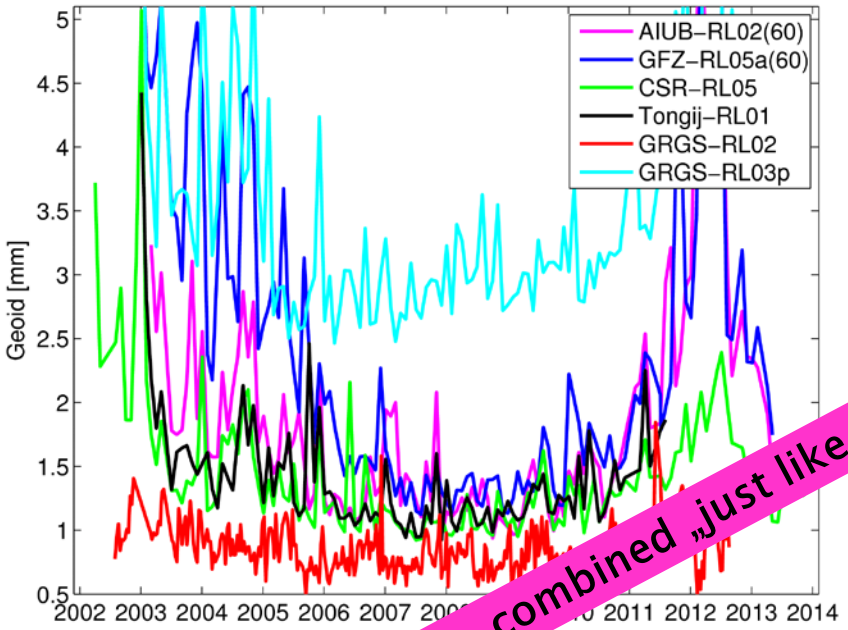
- weighted standard deviation (wSTD) over the oceans are computed to estimate the noise of the monthly solutions in a simple way



- an enlarged landmask is applied to compute the weighted STD in order to avoid leakage from continental regions with a strong hydrology signal

Noise assessment

wSTD over oceans (60)

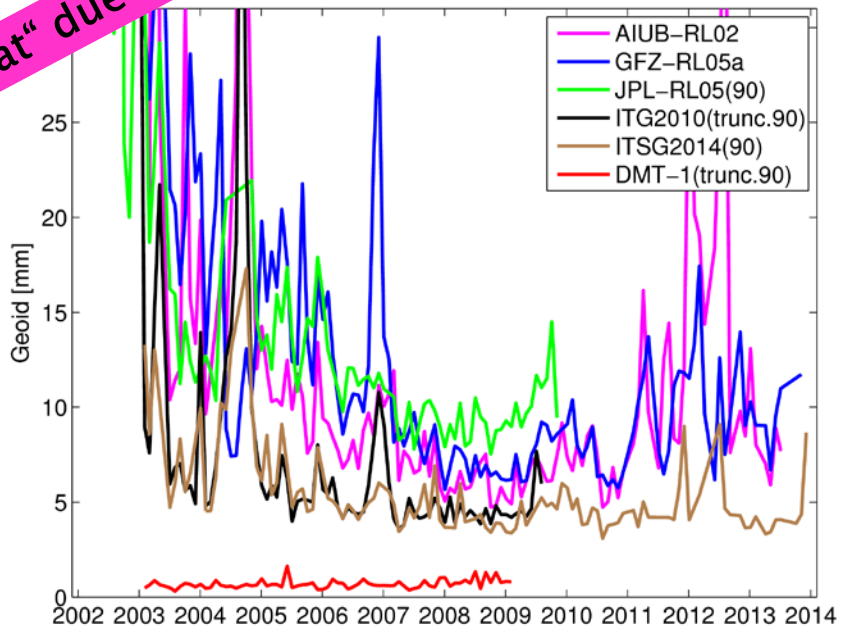


AIUB-RL02 (6 1.5 mm
GFZ-RL0 0): 1.8 mm
CSR 5: 1.3 mm
Tongji: 1.3 mm
GRGS-RL02 (50): 0.8 mm
GRGS-RL03p: 3.2 mm

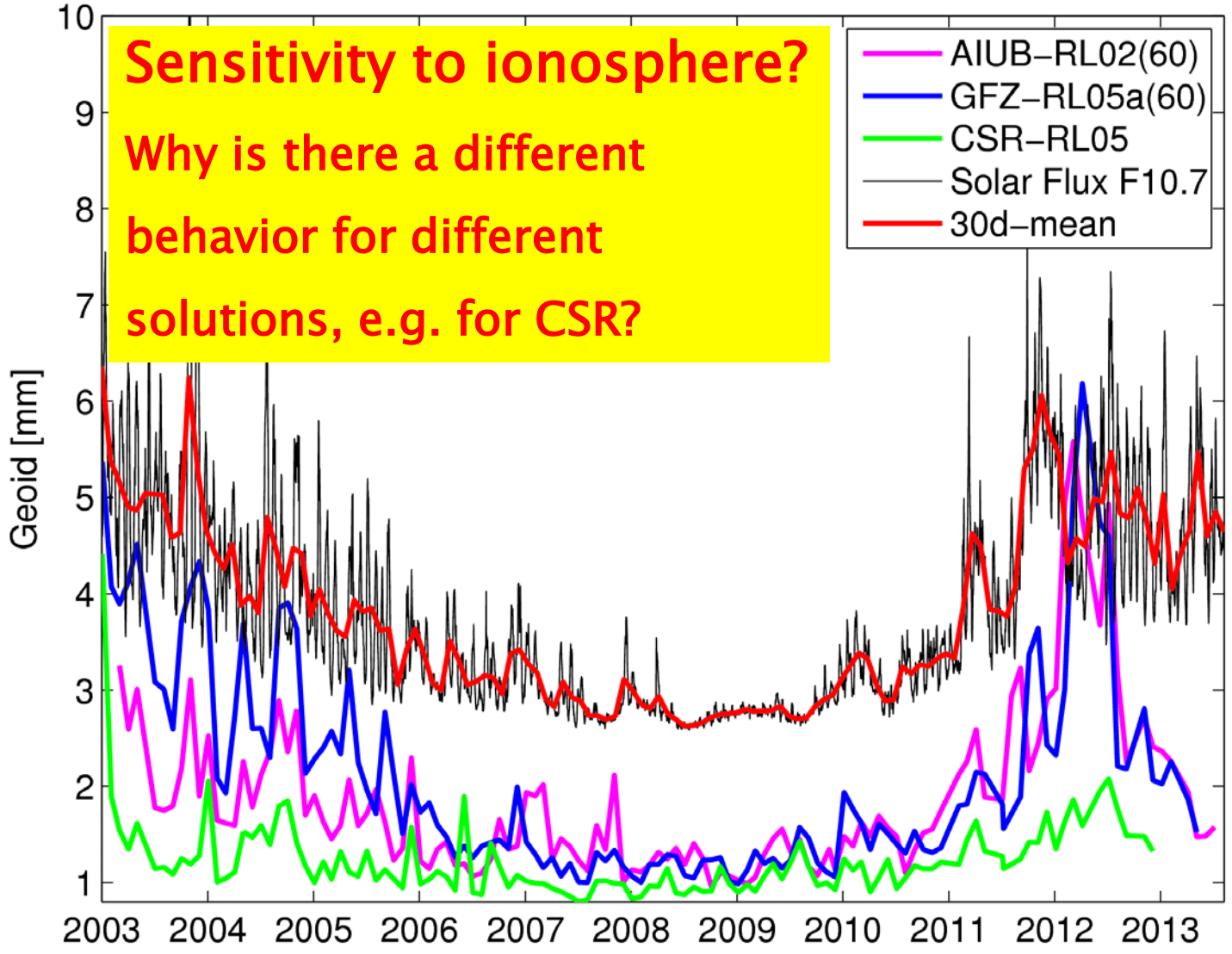
AIUB-RL02: 9.8 mm
GFZ-RL05a: 11.3 mm
JPL-RL05 (90): 11.
ITG2010 (trunc. 90): .2 mm
ITSG2014 (90): 5.3 mm
DMT-1 (t 90): 0.7 mm

Solutions cannot be combined „just like that“ due to different solution strategies

D over oceans (90)

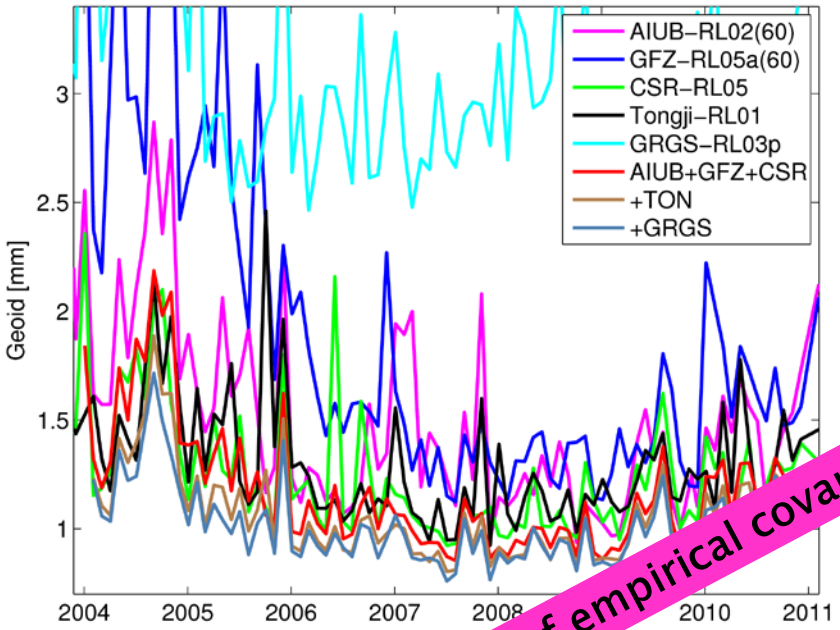


Noise assessment



Averaged monthly solutions
(input solutions based on similar strategies)

wSTD over oceans (60)

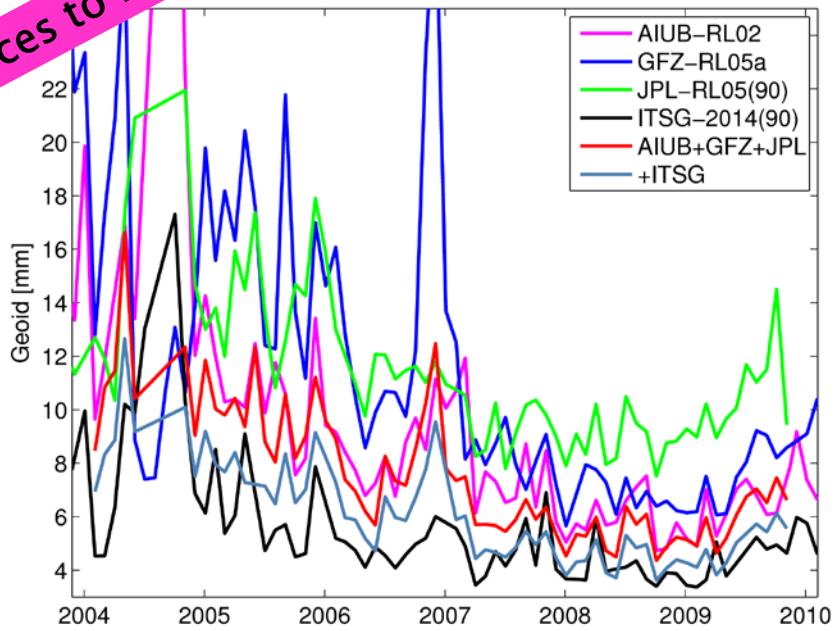


AIUB–RL02 (60): 1.5 mm
GFZ–RL05a (60): 1.8 mm
CSR–RL05: 1.3 mm
Tongji–RL01: 1.3 mm
GRGS–RL03p: 3.2 mm
Mean of 3: 1.2 mm
Mean of 4: 1.1 mm
Mean of 5: 1.0 mm

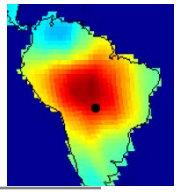
AIUB new (90): 9.8 mm
GFZ–RL05a (90): 11.3 mm
JPL–RL05 (90): [illegible] mm
ITSG–2014 (90): 5.3 mm
Mean of 3: 7.8 mm
Mean of [illegible]: 6.4 mm

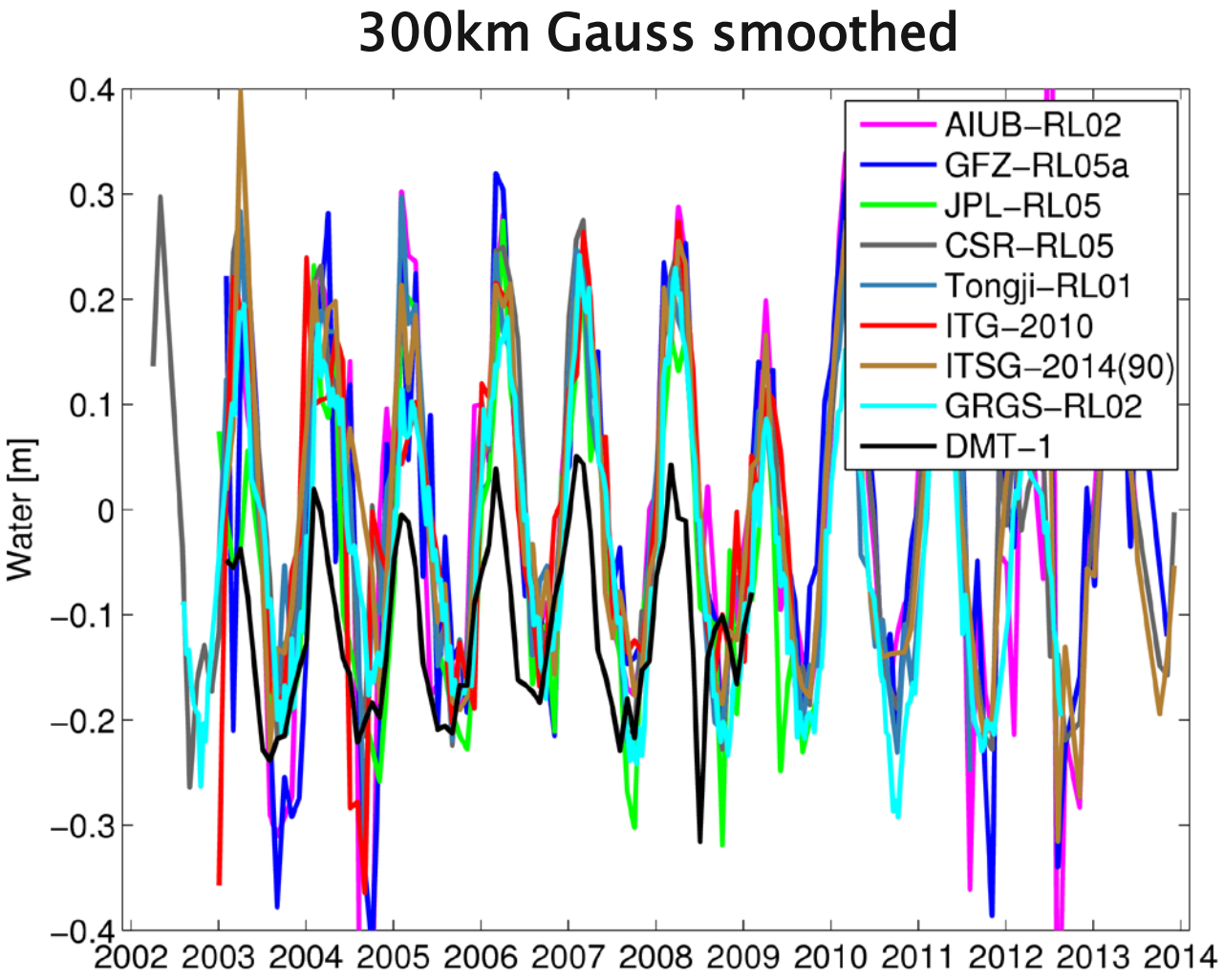
ITSG makes use of empirical covariances to model the noise behavior

[illegible]TD over oceans (90)

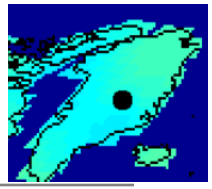


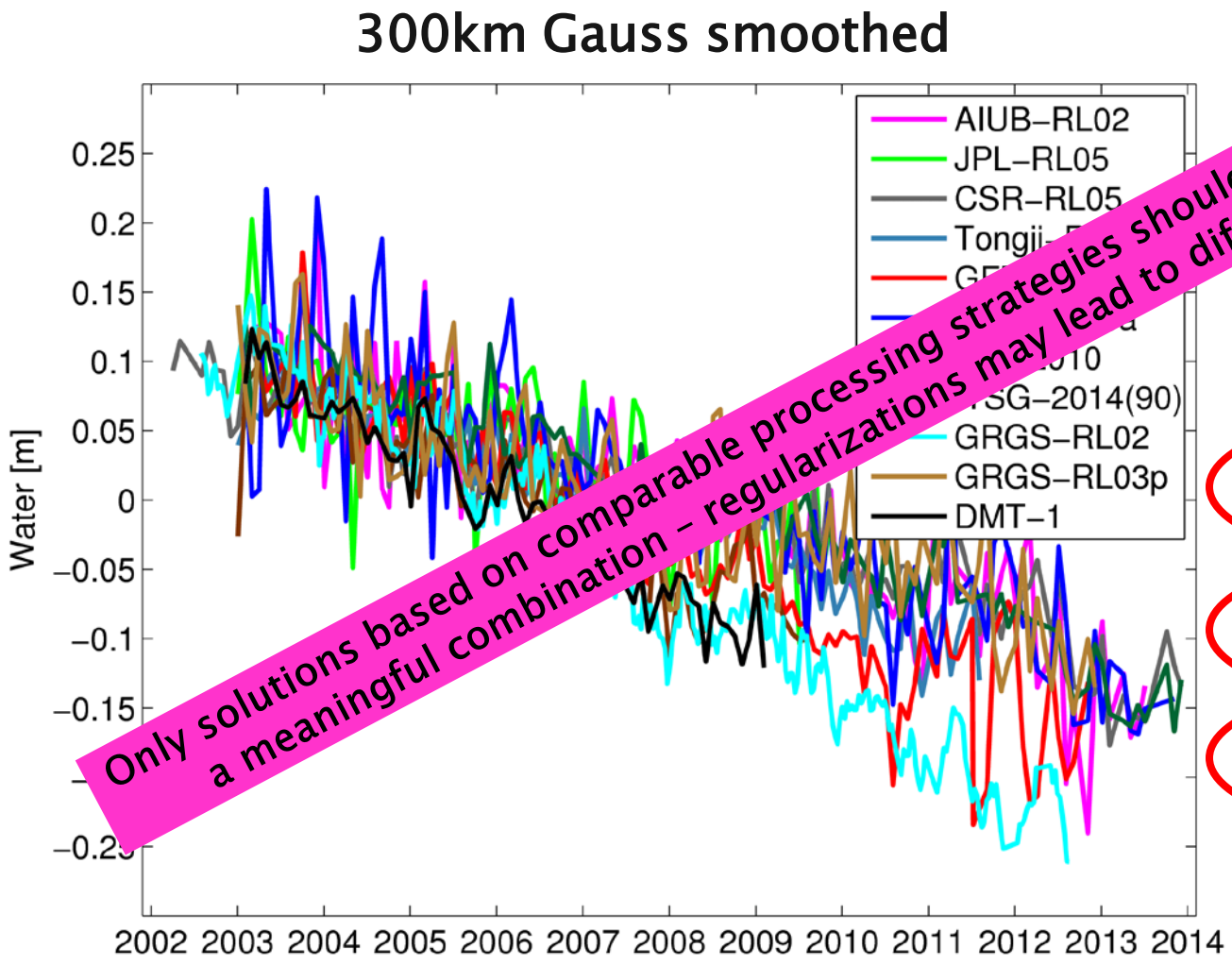
Signal (hydrology in South America)





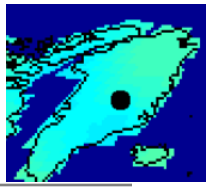
Signal (ice mass change in Greenland)



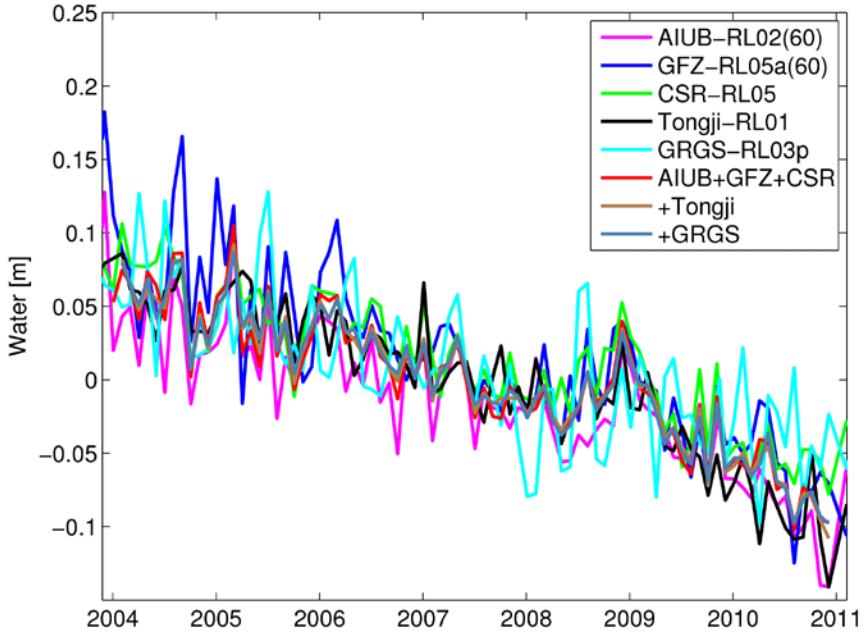


23±1.3 mm/y
JPL: −20±2.3 mm/y
CSR: −20±0.7 mm/y
TON: −22±0.9 mm/y
GFZ: −31±1.1 mm/y
GFZa:−24±1.4 mm/y
ITG: −28±1.6 mm/y
ITSG:−24±0.8 mm/y
GRGS:−36±0.4 mm/y
GRGS:−20±1.3 mm/y
DMT: −34±1.3 mm/y

Averaged monthly solutions
(input solutions based on similar strategies)



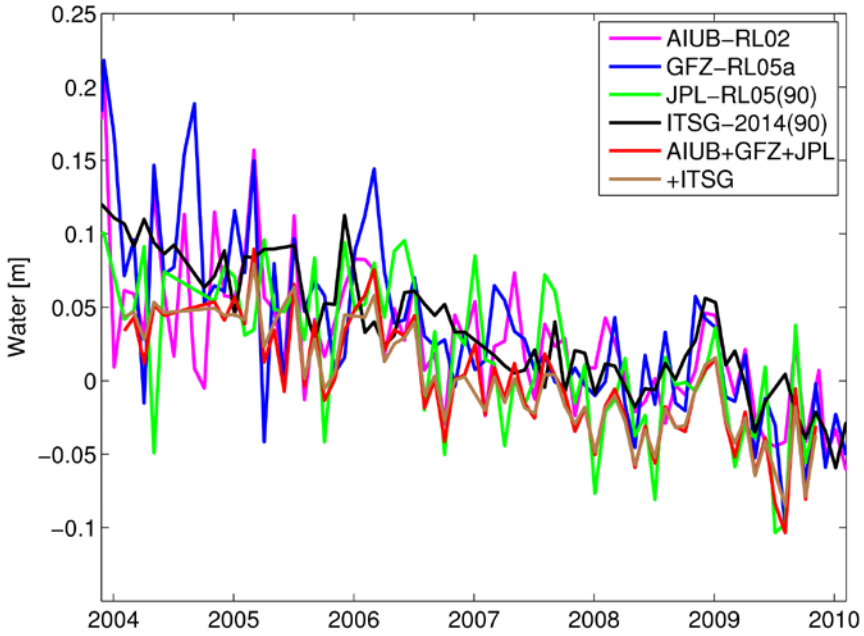
max. degree 60



AIUB-RL02 (60): −20±0.9 mm/y
GFZ5-RL05a (60): −20±1.2 mm/y
CSR-RL05: −20±0.7 mm/y
TON-RL01: −22±0.9 mm/y
GRGS-RL03: −20±1.3 mm/y
Mean of 3: −20±1.2 mm/y
Mean of 4: −20±1.1 mm/y
Mean of 5: −20±1.0 mm/y

AIUB-RL02: −23±1.3 mm/y
GFZ-RL05a: −24±1.4 mm/y
JPL-RL05(90): −20±2.3 mm/y
ITSG-2014 (90): −24±0.8 mm/y
Mean of 3: −19±2.0 mm/y
Mean of 4: −19±1.6 mm/y

max. degree 90



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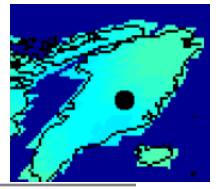
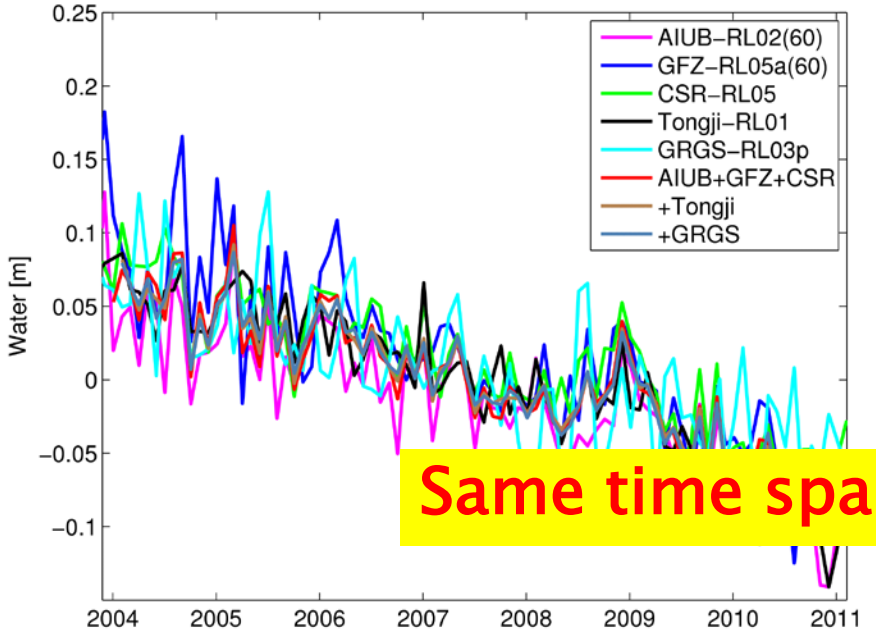
Averaged monthly solutions
(input solutions based on similar strategies)



max. degree 60

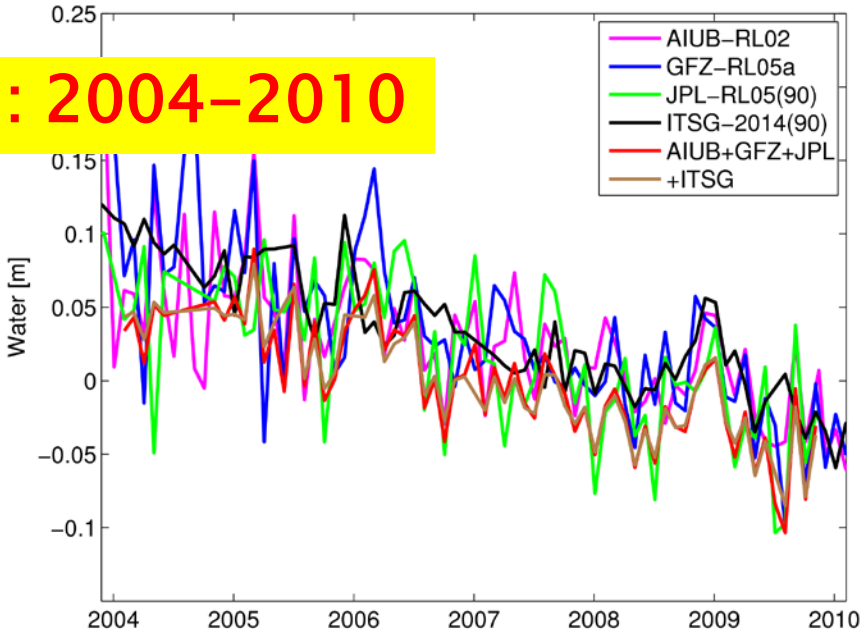


AIUB-RL02 (60): −19±1.4 mm/y
GFZ5-RL05a (60): −22±1.7 mm/y
CSR-RL05: −19±1.2 mm/y
TON-RL01: −24±1.2 mm/y
GRGS-RL03: −17±1.9 mm/y
Mean of 3: −20±1.2 mm/y
Mean of 4: −20±1.1 mm/y
Mean of 5: −20±1.0 mm/y

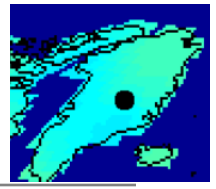
AIUB-RL02: −20±1.9 mm/y
GFZ-RL05a: −25±2.2 mm/y
JPL-RL05(90): −19±3.0 mm/y
ITSG-2014 (90): −22±1.2 mm/y
Mean of 3: −19±2.0 mm/y
Mean of 4: −19±1.6 mm/y

Same time span: 2004-2010

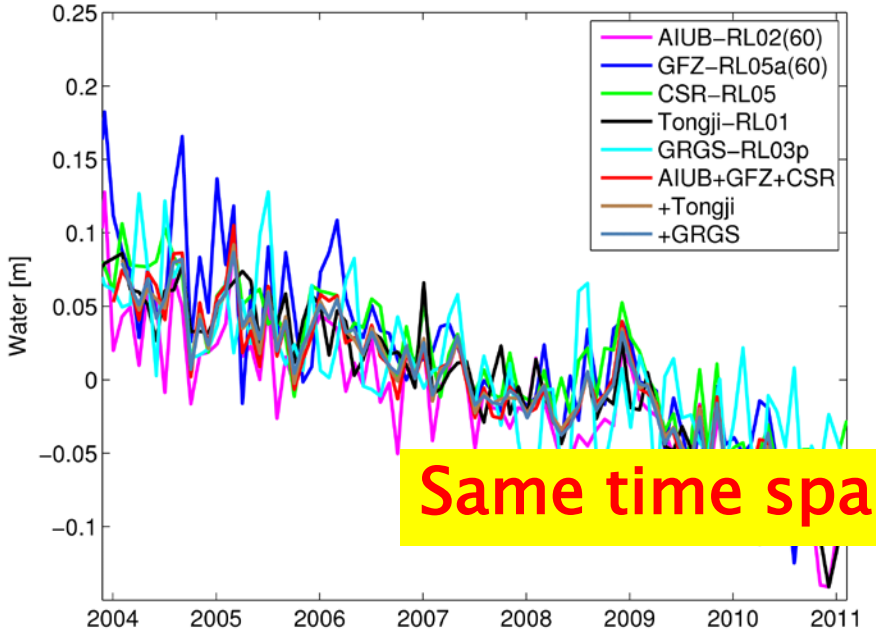
max. degree 90



Averaged monthly solutions
(input solutions based on similar strategies)



max. degree 60

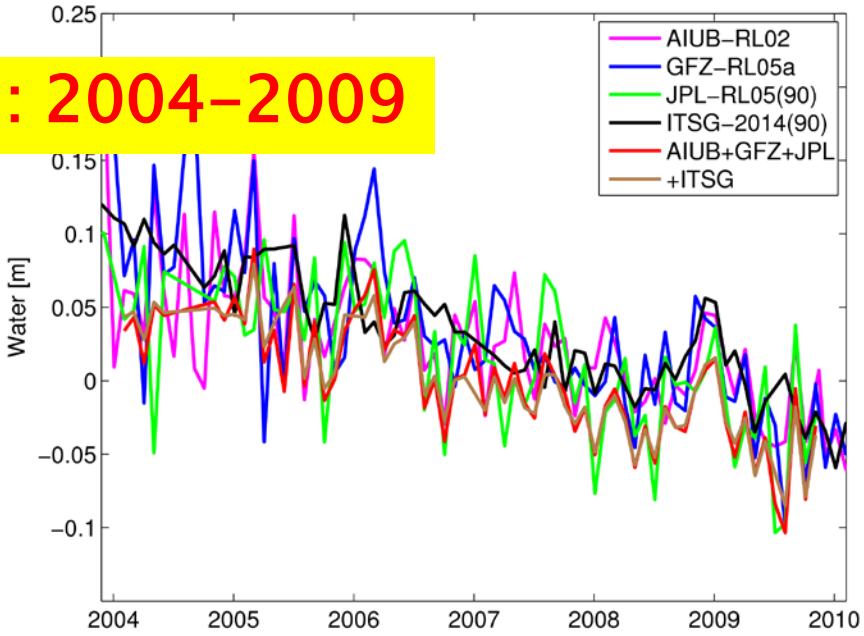


AIUB-RL02 (60): −15±1.7 mm/y
GFZ5-RL05a (60): −21±2.2 mm/y
CSR-RL05: −17±1.6 mm/y
TON-RL01: −20±1.4 mm/y
GRGS-RL03: −18±2.5 mm/y
Mean of 3: −20±1.2 mm/y
Mean of 4: −20±1.1 mm/y
Mean of 5: −20±1.0 mm/y

AIUB-RL02: −15±2.4 mm/y
GFZ-RL05a: −23±2.8 mm/y
JPL-RL05(90): −19±3.0 mm/y
ITSG-2014 (90): −20±1.5 mm/y
Mean of 3: −19±2.0 mm/y
Mean of 4: −19±1.6 mm/y

Same time span: 2004-2009

max. degree 90



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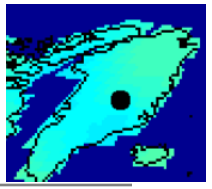
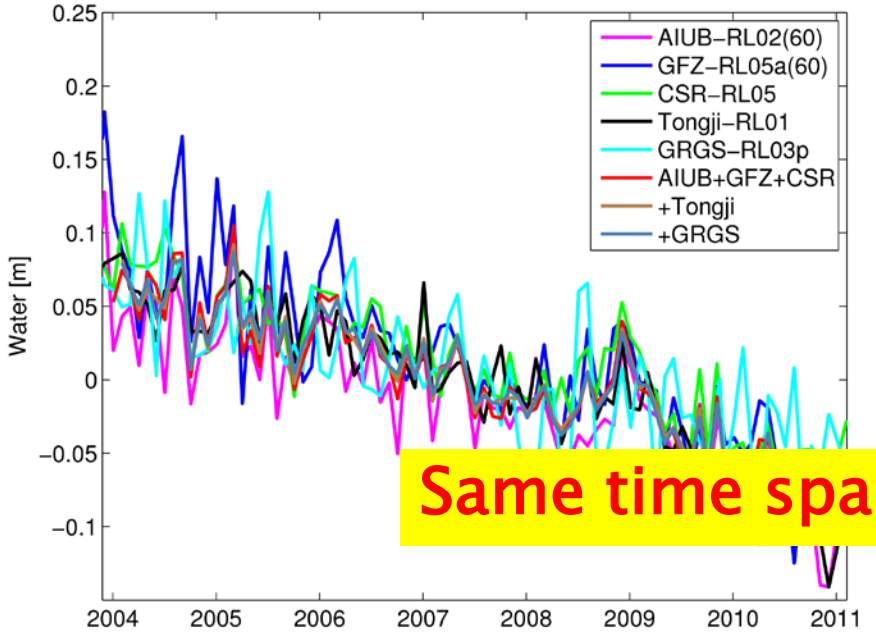
Averaged monthly solutions
(input solutions based on similar strategies)



max. degree 60

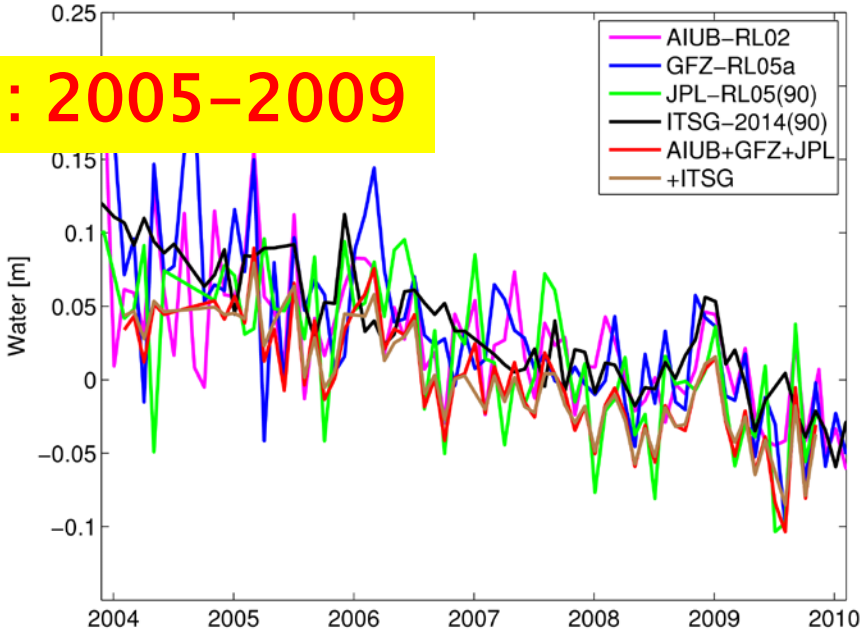


AIUB-RL02 (60): −16±2.1 mm/y
GFZ5-RL05a (60): −21±2.7 mm/y
CSR-RL05: −17±2.1 mm/y
TON-RL01: −22±1.7 mm/y
GRGS-RL03: −18±3.2 mm/y
Mean of 3: −20±1.2 mm/y
Mean of 4: −20±1.1 mm/y
Mean of 5: −20±1.0 mm/y

AIUB-RL02: −18±2.8 mm/y
GFZ-RL05a: −22±3.3 mm/y
JPL-RL05(90): −22±3.6 mm/y
ITSG-2014 (90): −19±2.0 mm/y
Mean of 3: −19±2.0 mm/y
Mean of 4: −19±1.6 mm/y

Same time span: 2005-2009

max. degree 90



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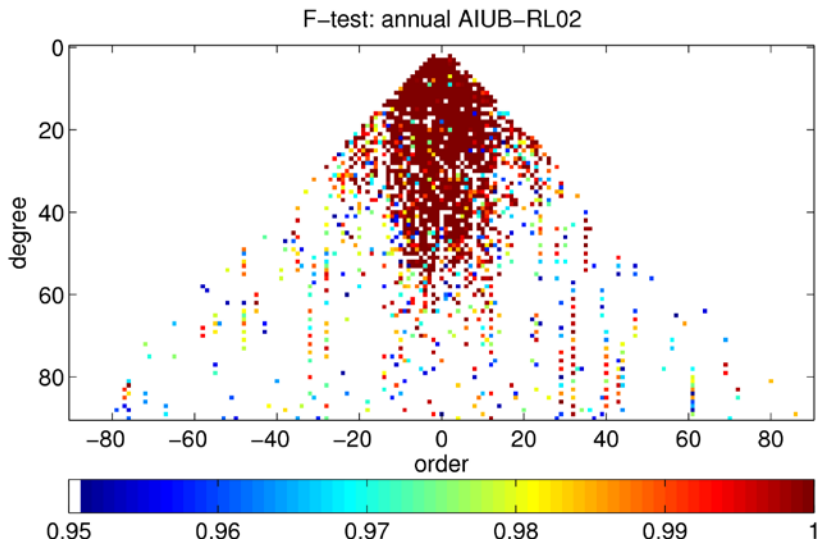
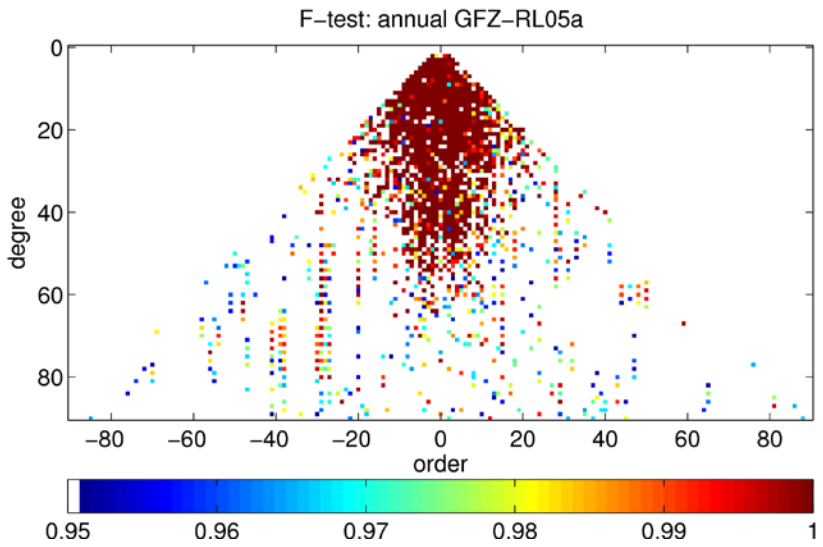
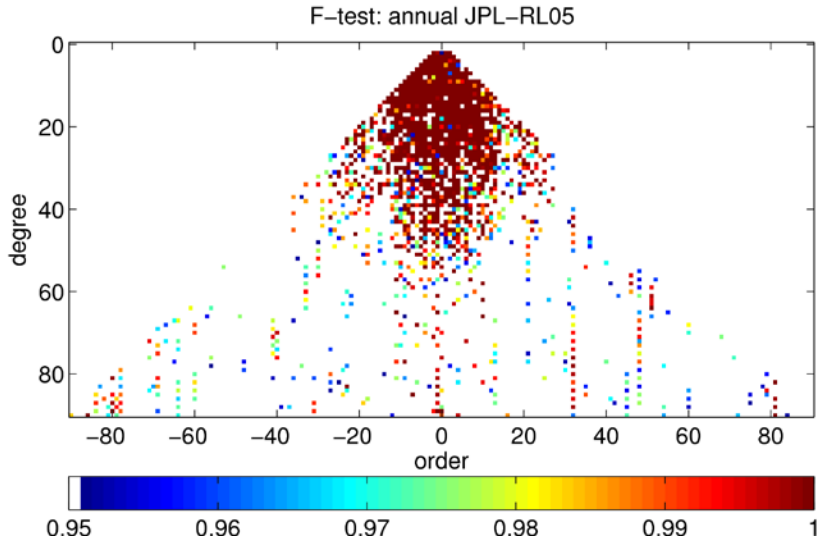
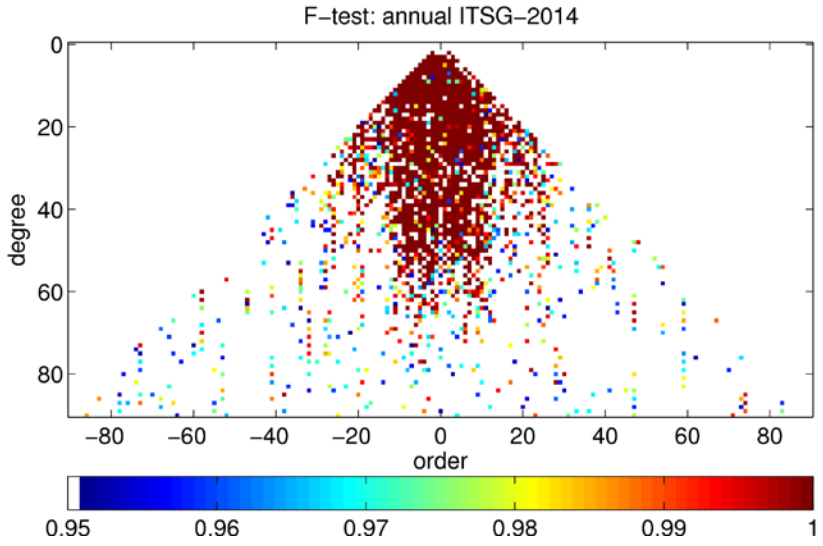
Coefficient-wise significance of annual variations

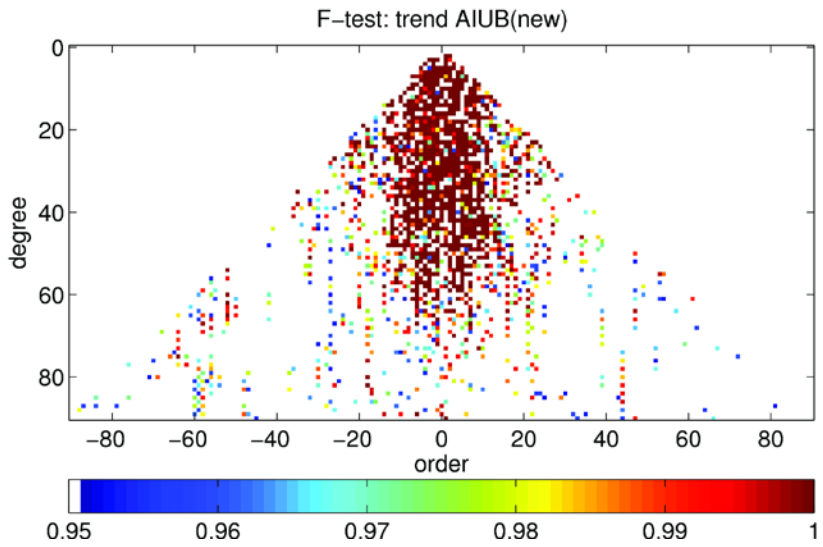


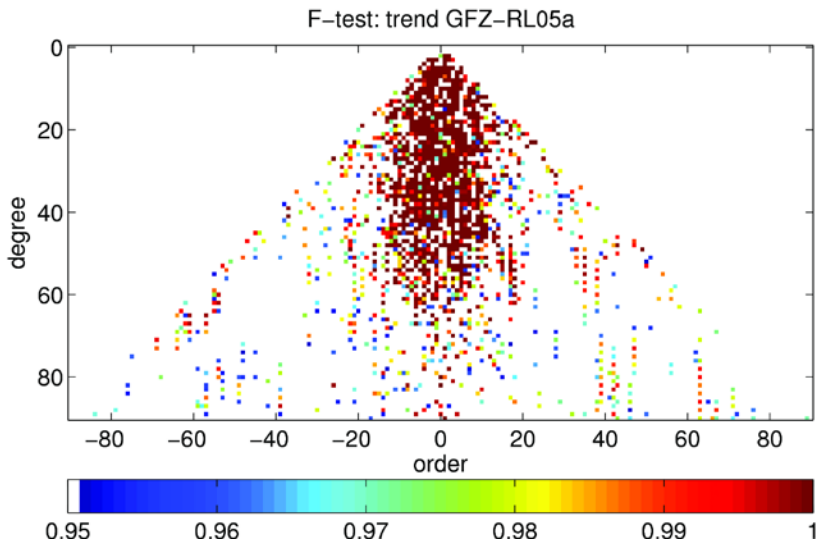


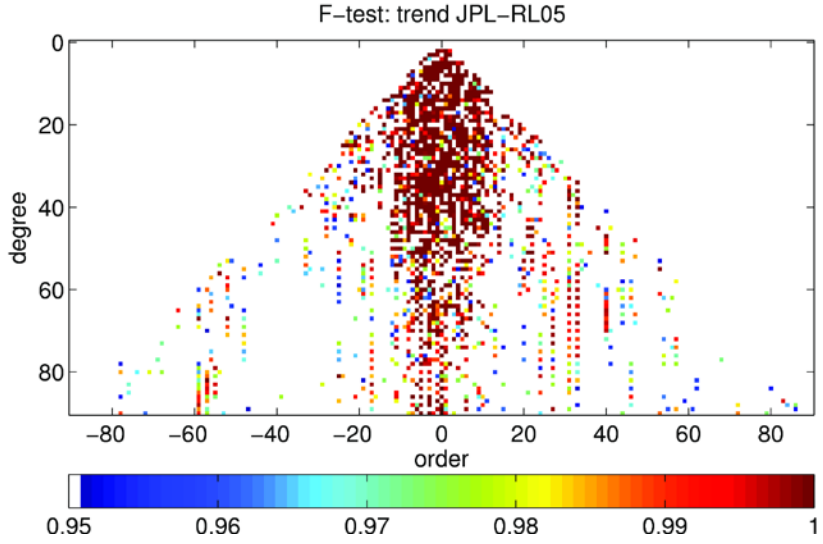


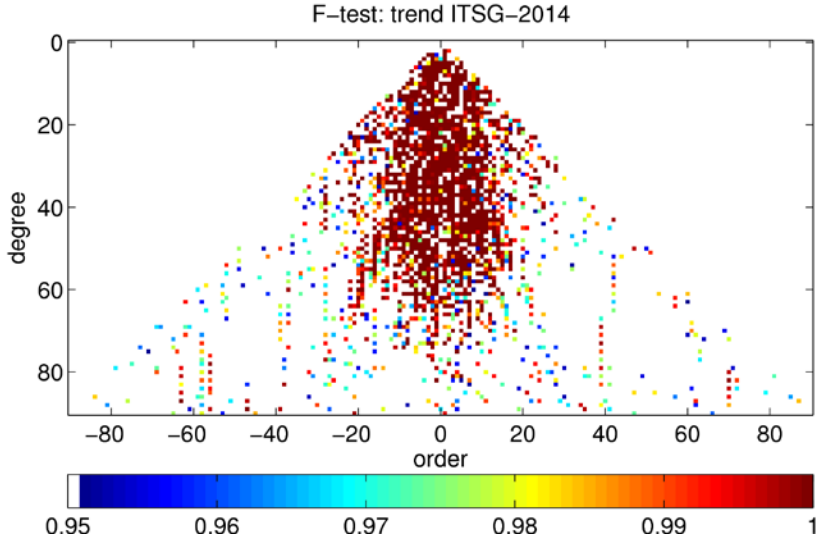


Coefficient-wise significance of trends









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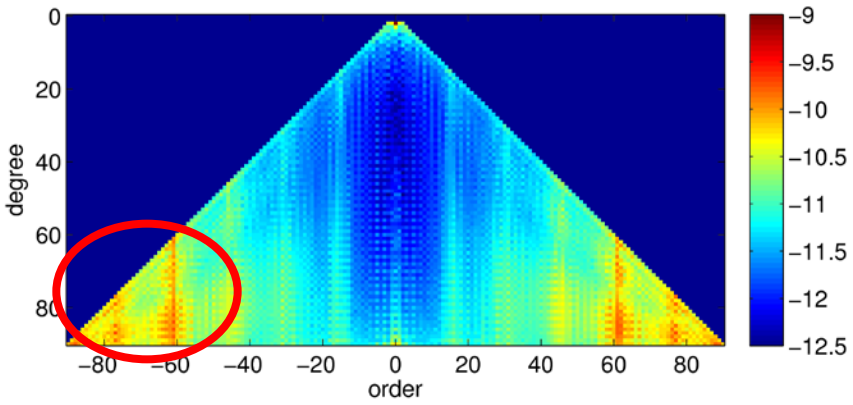
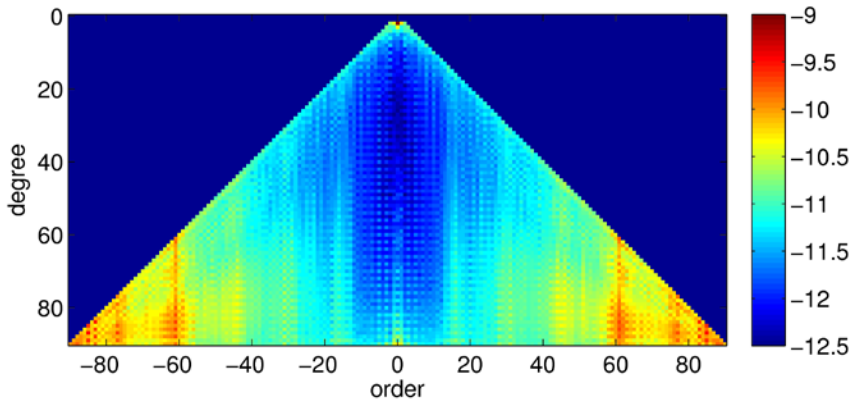
RMS of monthly differences per coefficient

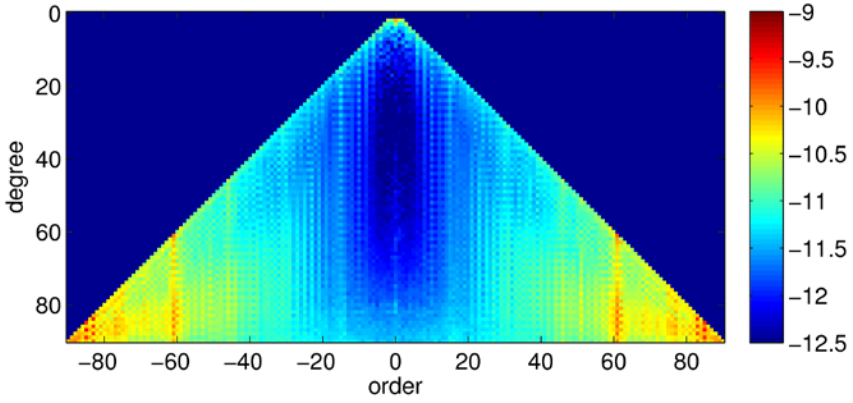
JPL-RL05 - AIUB-RL02



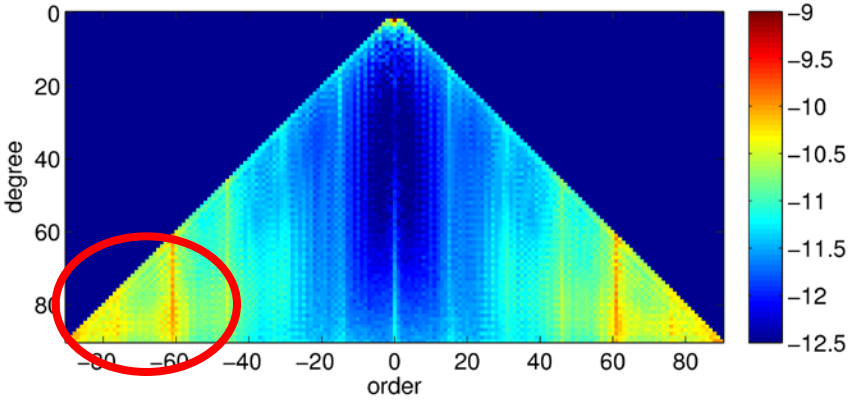
JPL-RL05 - GFZ-RL05a



GFZ-RL05a - AIUB-RL02

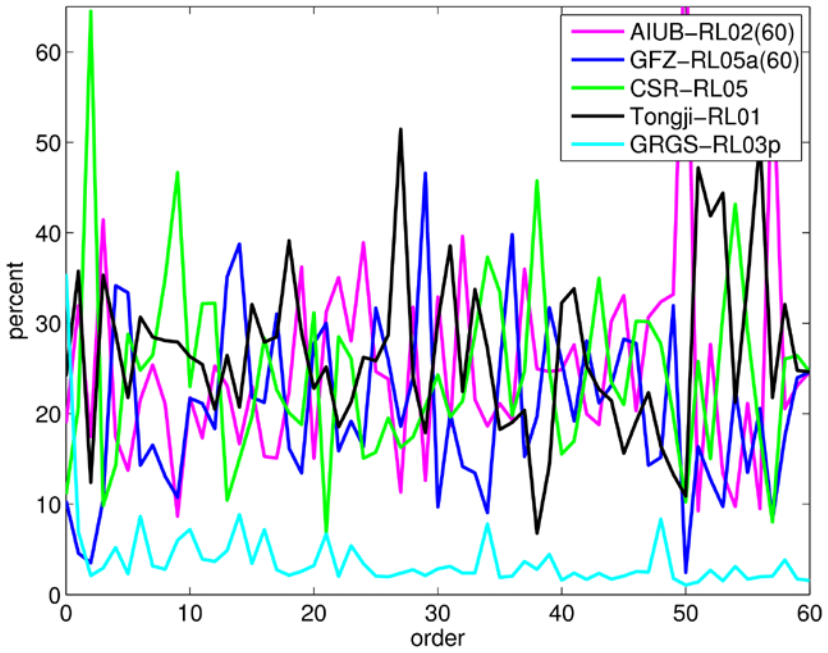


ITSG-2014 - AIUB-RL02



Monthly relative weights (example 03/2008)

Contribution per order



Mean:

AIUB: 25 %

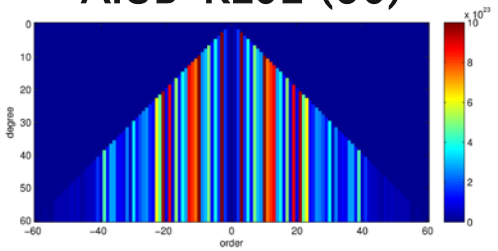
GFZ: 20 %

CSR: 24 %

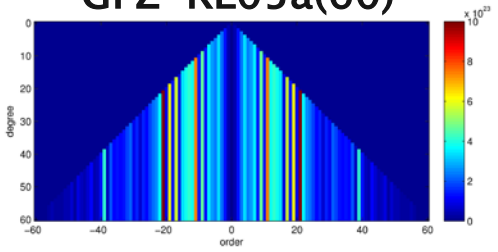
TON: 27 %

GRGS: 4 %

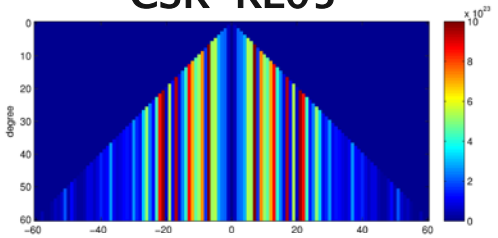
AIUB-RL02 (60)



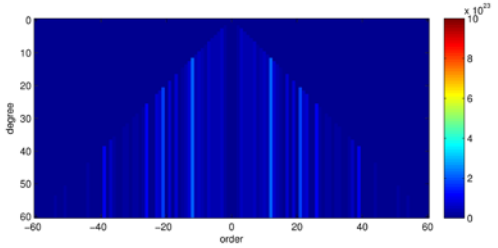
GFZ-RL05a(60)



CSR-RL05



GRGS-RL03p



Percent: $100\% * w_i/(w_1+w_2+w_3)$

Weight matrix: $1/RMS^2$ per order

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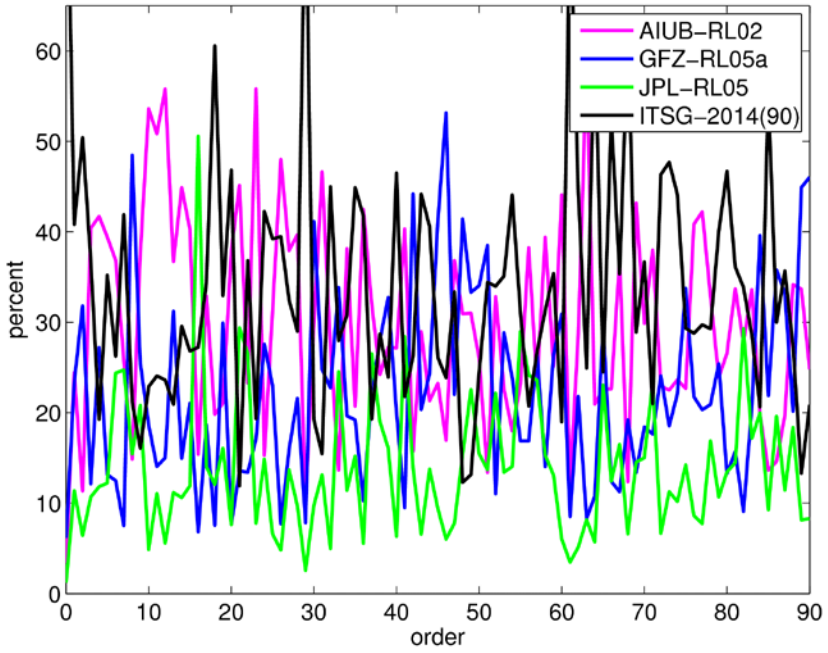
Monthly relative weights 90 (example 03/2008)

Contribution per order



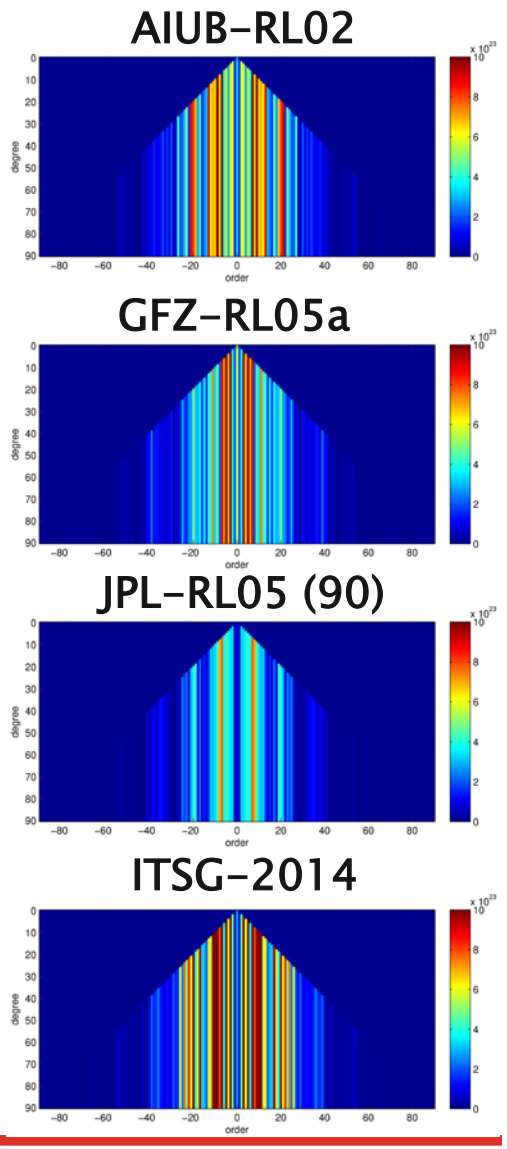
Mean:

AIUB: 30 %

GFZ: 22 %

JPL: 14 %

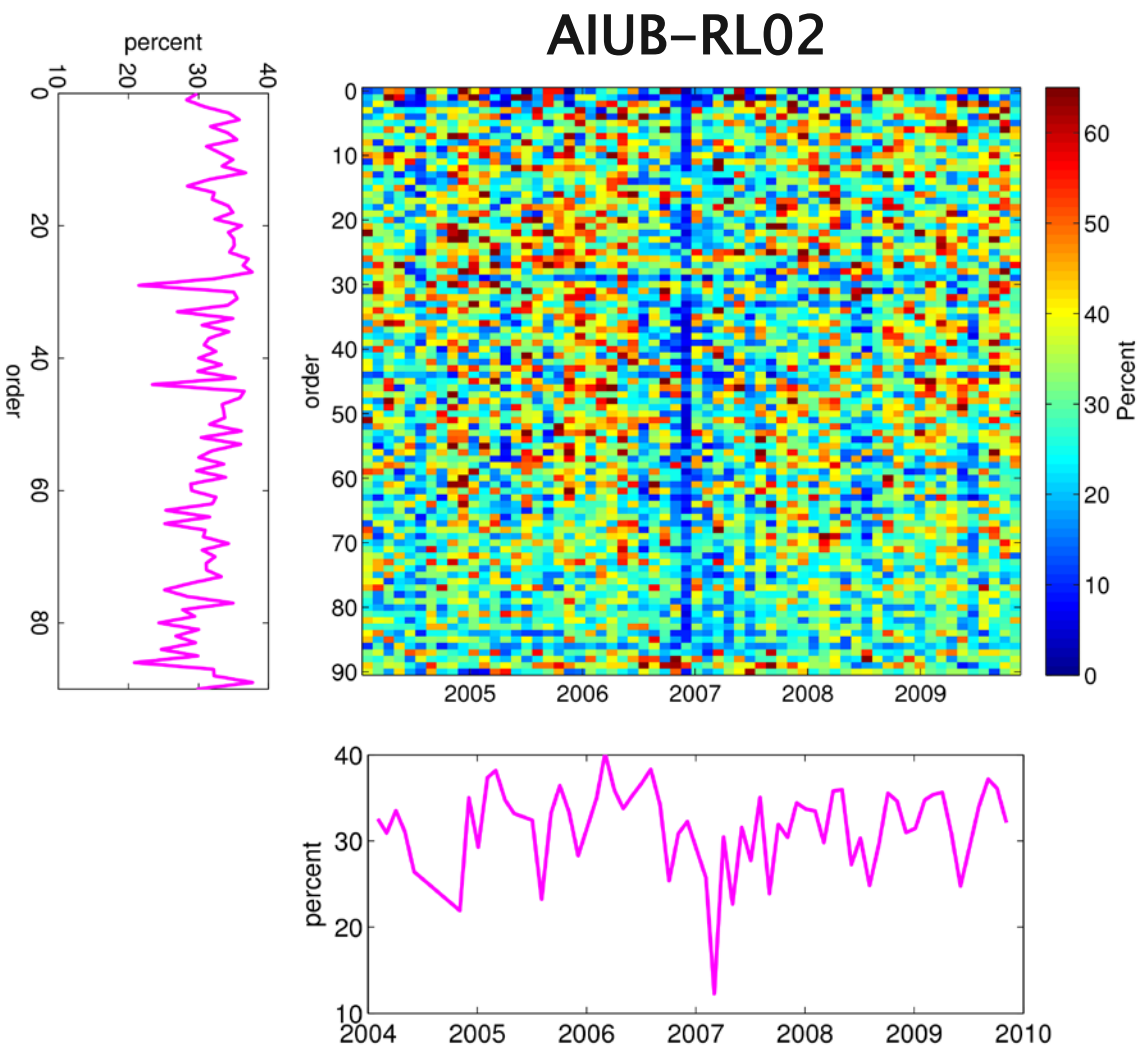
ITSG: 34 %



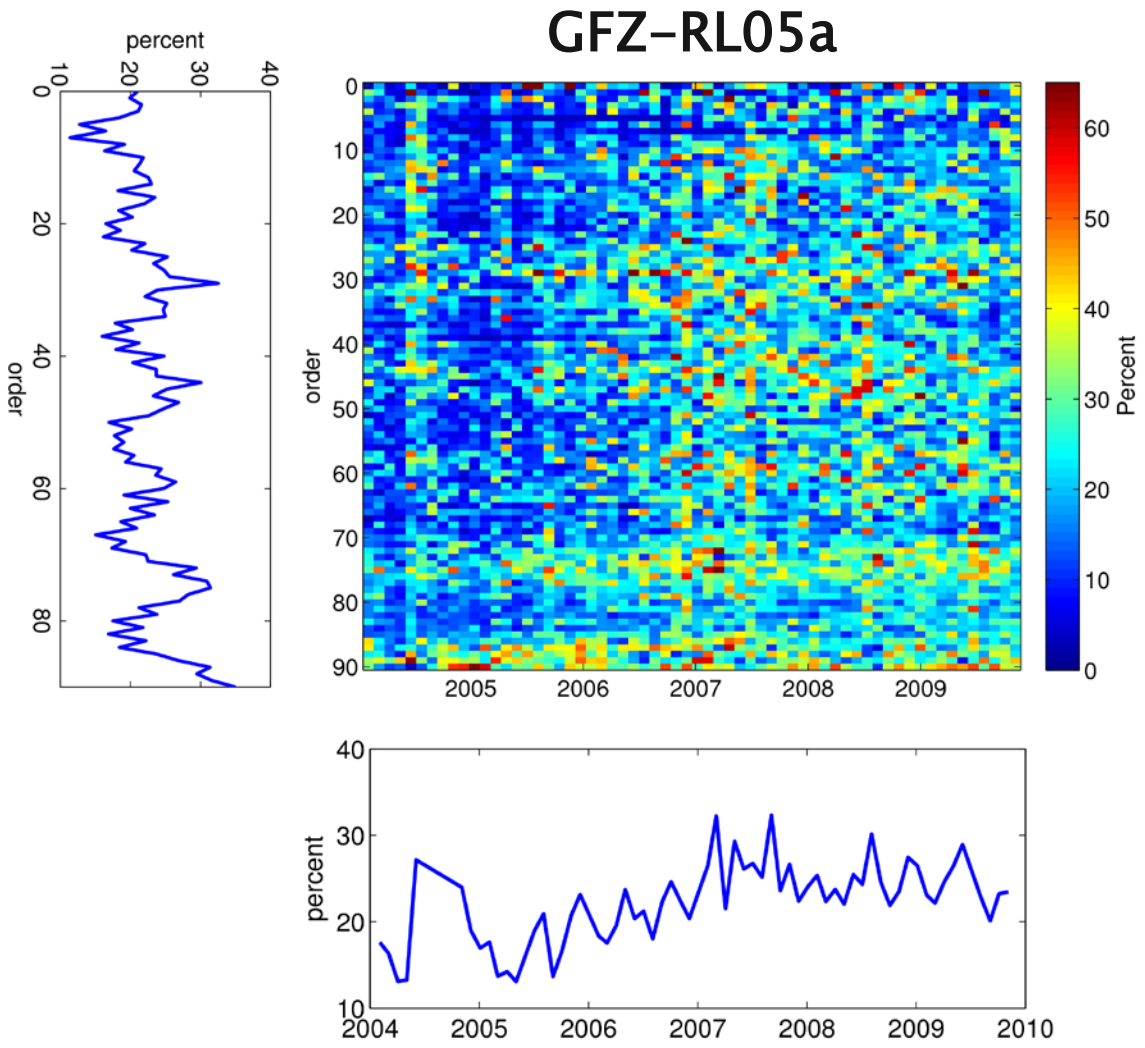
Percent: $100\% * w_i/(w_1+w_2+w_3)$

Weight matrix: $1/RMS^2$ per order

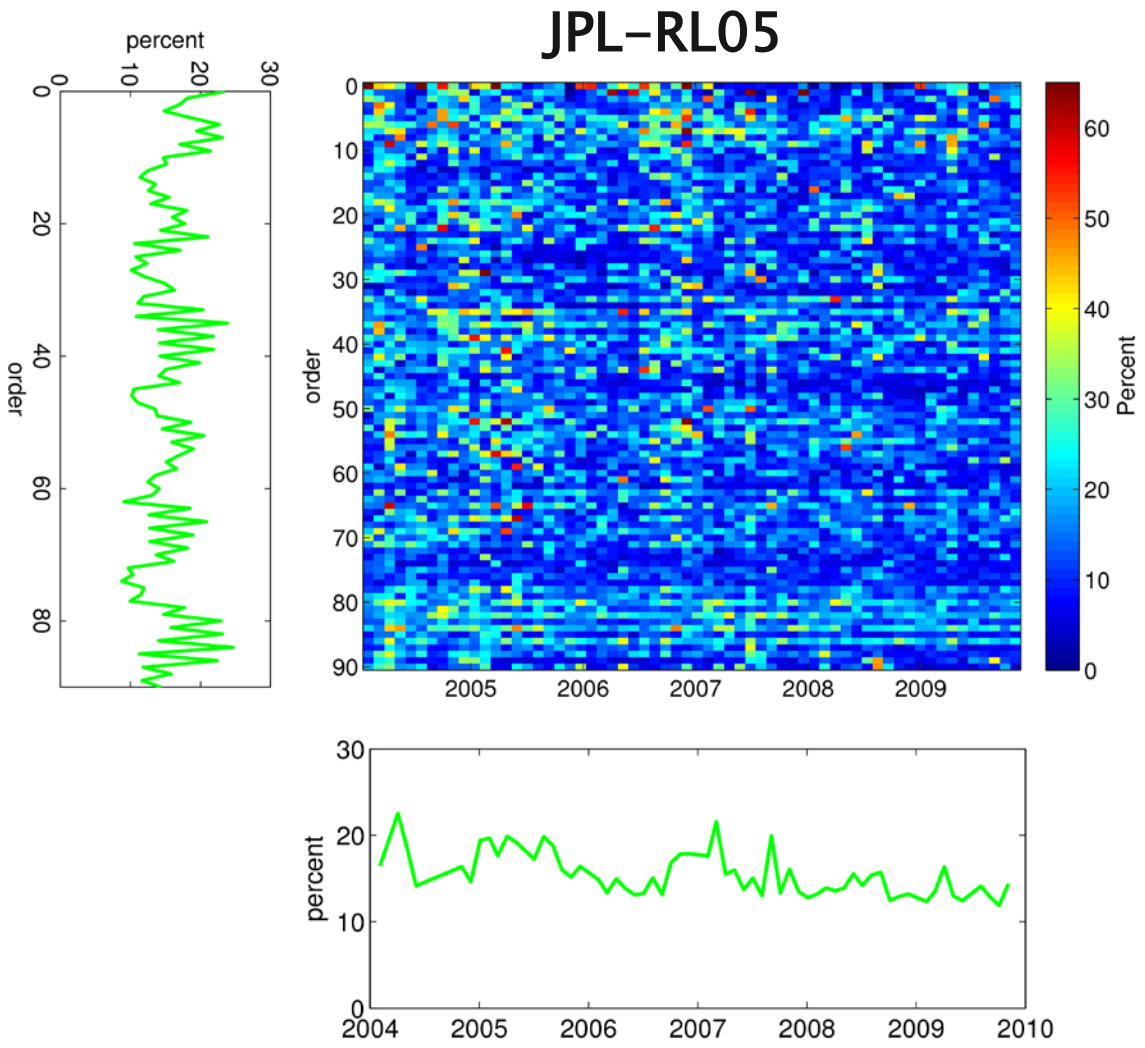
Monthly relative weights 90



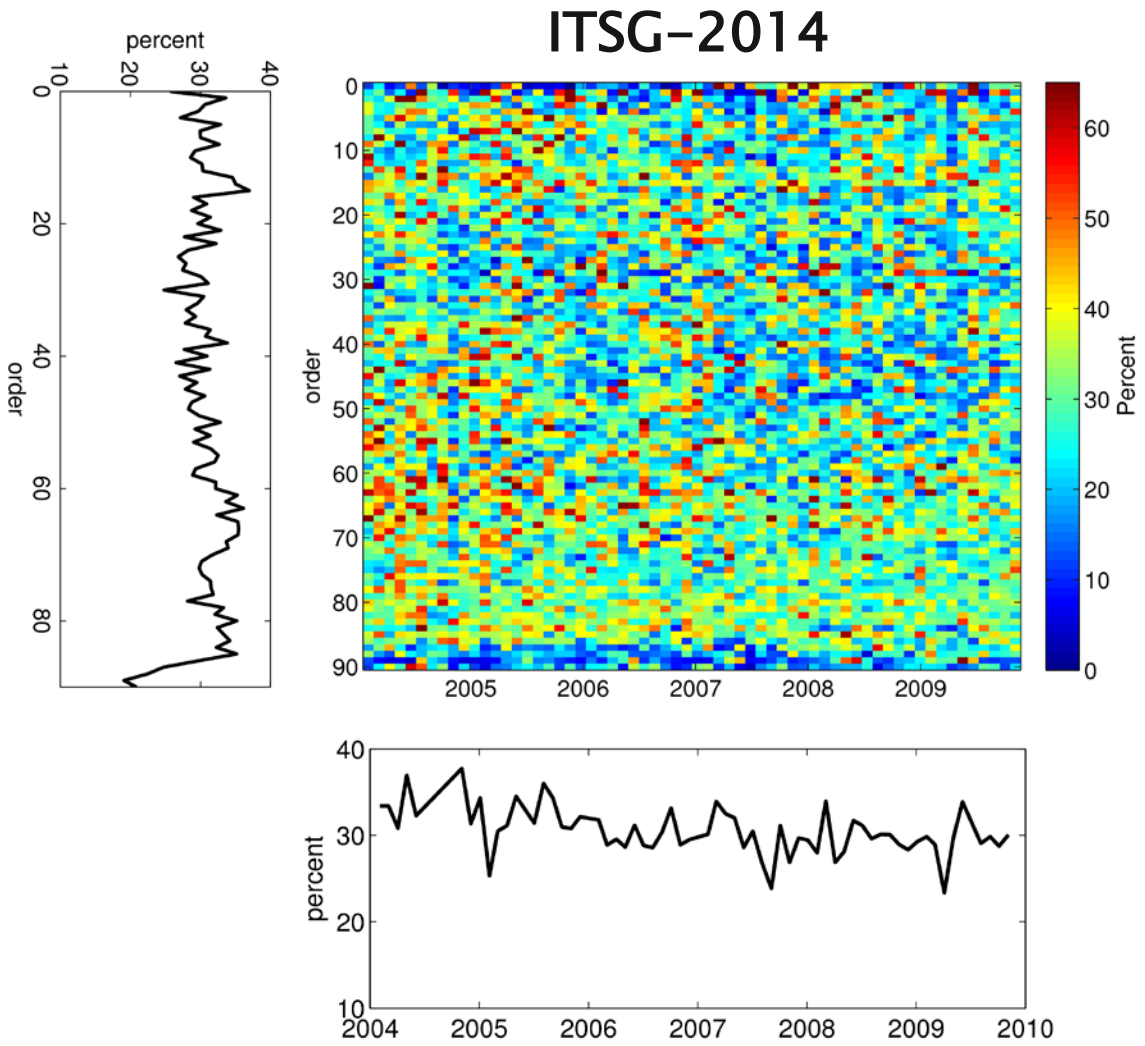
Monthly relative weights 90



Monthly relative weights 90



Monthly relative weights 90



Summary in view of GRACE-FO

- A service should be established consisting of:
  - A larger number of Analysis Centers (ACs) providing time-variable gravity field solutions on a regular basis
  - Analysis Center Coordinator (ACC)
- Comparable processing strategies are mandatory to ensure meaningful results of the ACC work:
  - Comparison of the AC solutions (gravity field solutions, orbits, residuals), identification of problematic solutions
  - Pairwise comparison of solutions to derive approximate empirical weights for the individual ACs
  - Combination of all AC gravity fields, either by:
    - Calculating a weighted average of the gravity field parameters based on the previously derived weights
    - Combining the solutions based on normal equations generated by the individual ACs